EVALUATION OF EFFECT OF THREE DIFFERENT SOLUTIONS ON MECHANICAL PROPERTIES OF HEAT CURED AND MICRO WAVE CURED DENTURE BASE RESIN-IN VITRO STUDY

A Dissertation Submitted to the

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In partial fulfillment of the requirement for the degree of

MASTER OF DENTAL SURGERY

(BRANCHI)
(PROSTHODONTICS AND CROWN & BRIDGE)

APRIL 2013

CERTIFICATE

This is to certify that this dissertation titled "**EVALUATION OF EFFECT OF THREE DIFFERENT SOLUTIONS ON MECHANICAL PROPERTIES OF HEAT CUREDAND MICRO WAVE CURED DENTURE BASE RESIN-IN VITRO STUDY"** a bonafide record of work done by **Dr.P.Mohankumar**under my guidance during his postgraduate period 2010-2013. This dissertation is submitted to **Tamilnadu Dr. MGR Medical University**, **Chennai** in partial fulfillment, for the degree of **Master of Dental Surgery in Prosthodontics and Crown and Bridge (Branch-1).**

It has not been submitted (partial or full) for the award of any other degree or diploma. **Guided By**

Dr. C. Thulasingam, M.D.S.
Professor and Head of the Department
Department of Prosthodontics
Tamilnadu Government Dental College
& Hospital, Chennai- 600003

Head of institute
Prof. Dr K.S.G.A. NASSER, M.D.S.
Tamilnadu Government Dental College & Hospital, Chennai- 600003

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DECLARATION

I, Dr.**P.Mohankumar**, do hearby declare that the dissertation **"EVALUATION OF EFFECT OF THREE DIFFERENT SOLUTIONS ON MECHANICAL PROPERTIES OF HEAT CUREDAND MICRO WAVE CURED DENTURE BASE RESIN-IN VITRO STUDY"** was done in the Department of Prosthodontics, Tamilnadu Government Dental College & Hospital, Chennai- 600003. I have utilized the facilities provided in the Government Dental College for this study in partialfulfillment of the requirements for the degree of Master of Dental Surgery in Prosthodontics and Crown and Bridge (Branch -1) during the course period 2010-2013 under the conceptualization and guidance of my dissertation guide **Dr. C. Thulasingam, M.D.S.**

I declare that no part of the dissertation will be utilized for gaining financial assistance for research or other promotions without obtaining prior permission from theTamilnadu Government Dental College & Hospital, Chennai- 600003

I also declare, that no part of this work will be published either in the print or electronic media except with those who have been actively involved in this dissertation work, and I firmly affirm that the right to preserve or publish this work rests solely with the permission of the Principal, Tamilnadu Government Dental College & Hospital, Chennai- 600003, but with the vested right that I shall be cited as the author(s).

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And **Dr.P.Mohankumar** currently studying as **Post Graduate** Student in Department of Prosthodontics, Tamilnadu Government College and Hospital, Chennai – 3 (herein after referred to as the 'PG Student and co-investigator')

Whereas the PG Student as part of his curriculum undertakes to research on "**EVALUATION OF EFFECT OF THREE DIFFERENT SOLUTIONS ON MECHANICAL PROPERTIES OF HEAT CUREDAND MICRO WAVE CURED DENTURE BASE RESIN-IN VITRO STUDY**" for which purpose the principal investigator shall act as principal investigator and the college shall provide the requisite infrastructure based on availability and also provide facility to the PG Student as to extent possible as a Co-investigator.

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10. If any dispute arises as to the matters related or connected to this agreement herein, it shall be referred to arbitration in accordance with the provisions of the Arbitration and Conciliation Act, 1996.

In witness where of the parties hereinabove mentioned have on this the day month and year herein above mentioned set their hands to this agreement in the presence of following two witnesses.

College represented by its **Principal Student guide**

PG Student

Witness

1.

2.

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ABSTRACT

Title :EVALUATION OF EFFECT OF THREE DIFFERENT SOLUTIONS ON MECHANICAL PROPERTIES OF HEAT CURED AND MICRO WAVE CURED DENTURE BASE RESIN-IN VITRO STUDY

Aims andObjectives.To evaluate the mechanical properties of heat cured and micro wave cured denture base resin after immersing in different fluids routinely used in day to day life. To find out the effect of fluids used in day to day life on the Flexural strength of the heat cured resin and micro wave cured resin.To find out the effect of fluids on the Impact strength of the heat cured resin and micro wave cured resin.

Method: Eighty samples of heat cured acrylic resin and microwave cured resin were prepared .Then they were divided into four subgrouped which were immersed in chlorinatedwater,coffee and aerated drink.After which they were subjected to flexural and impact strength analysisusing universal testing machine and Charpyimpact tester.

Results: Flexural and impact strength were measured and the mean values obtainedfor heat cured and microwaved cured resins using SPSS software statistical analysis was done. It shows specimen immersed in aerated drink has significant difference in values than other sub groups.

Conclusion: Micro wave cured resin has showed a significant increase in flexural strength and Impact strength than heat cured resin. The aerated drink has more deleterious effect on the impact and flexural strength of samples of micro wave cured and heat cured acrylic resins and it is followed by coffee and chlorinated water.

INTRODUCTION

INTRODUCTION

Replacement of missing natural tooth had been started in 17 thcentury itself. So many workers tried so many materials starting from animal bone to Polymers. Various materials such as Charles Goodyear's discovery of vulcanized rubber in 1840. John Hyatt discovery of the first plastic molding material celluloid in1868, Dr. Leo Bakeland discovered phenol formaldehyde resins such as Bakelite in 1909, were developed for denture fabrication later metals and metal alloys were also tried.[1]

The poly methyl methacrylate was introduced by Dr. Walter, Wright[1] and the Vernon brothers in 1937 which is then brought about improvement in denture construction with good esthetics, dimensional stability, ease of processing and accurate fit.[1,3]Since then poly methyl methacrylate resin polymers made a remarkable improvements in the construction of denture bases 95% of all dentures are now constructed by poly methyl methacrylate polymers.[2,3]

The excellent working characteristics of poly methyl methacrylate made its usage as a wide open in the Dental and Medical field.

The polymerization of poly methyl methacrylate involves a series of chemical reactions such as initiation, propagation, termination and chain transfer.[4]

Polymerization of poly methyl methacrylate is initiated by breaking down the benzoyl peroxide to form free oxygen radicals by heat or chemical source. These act upon the vinyl group of methyl methacrylate opening the double bond causing formation of a new single carbon bond. This is known as a free radical addition polymerization chain reaction.[4,5]

During the polymerization process two or more polymer chains may get initiated depending on the quantity of glycol dimethacrylate a crosslinking agent included in the mixture. The opening of each double bond results in production of another free radical, which in turn attack and join another double bond. This results in production of another free radical and continuation of the reaction. This repeated reaction is referred to as chain propagation.[5]

The free radicals attack at this point and link the methyl methacrylate molecules together by methylene bridges (–CH2-). These chains carrying active free radical are referred to as growing or live chains.[6,5]

Chain termination can occur at any time and is dependent upon the quantity of available free radicals.Chain termination results from the depletion of all free radicals. These free radicals maybe released from a chain or from the initiator. The transfer of a hydrogen atom (hydrogen abstraction) in the system to the attacking free radical (terminal position of the chain) results in termination of one chain reaction.[7]

This new chain reaction may or may not be on an existing polymer chain The free radical formed from the methyl methacrylate double bond is not symmetrical. This results in a carbon atom that also has an asymmetrical environment after reaction.

The presence of Saliva and Oral fluids and the oral consumption of the individuals may have their impact on the denture base and tooth. Variations of P^H and temperature of these fluids have been considered as the causative factors. They have a tendency to interfere or weakened the chains which are already formed by means of polymerization.[8,9]

Sorption is a process of absorption and adsorption of liquids and oral fluids. The absorption is undoubtedly due primarily to the polar properties of resin molecules.[8]

Solubility is the soluble substances leached out during storage in water and in the oral fluids. The phenomena of sorption and solubility producing deleterious effects. These effects may include volumetric changes such as swelling, physical changes such as plasticization and softening, and chemical changes such as oxidation and hydrolysis.[8,9,10,11]

The effect of various beverages and medicaments has not been studied in detail in the past. Keeping this as a background this in vitro study is proposed with following aims and objectives.

AIMS

AND

OBJECTIVES

AIM:

To evaluate the mechanical properties of heat cured and micro wave cured denture base resin after immersing in different fluids routinely used in day to day life.

OBJECTIVES:

1) To evaluate the Flexural strength and Impact strength of heat cured denture base resin after immersed in three different fluid medium.

2) To evaluate the Flexural strength and Impact strength of microwave cured denture base resin after immersed in three different fluid medium.

3) To compare the Flexural strength of heat cured and microwave cured denture base resin after immersion in three different fluid medium.

4) To compare the Impact strength of heat cured and microwave cured denture base resin after immersion in three different fluid medium.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

Nishii M (1968)[18] Introduced denture base polymerization through microwave irradiation and became increasingly popular as an alternative to conventional water bath processing and microwave polymerization has several advantages.

J.P.DeClerck (1987)[19]Concluded in his study that microwave processing has a potential for saving time and money in processing dentures. Microwave oven cured resin has a lower residual monomer ratio and the same physical properties as conventionally cured resin. It requires at least special flasks and programmable microwave oven, but specially designed equipment will give the best results.

Jun-ichi OKU (1989)[20]Conducted a study to find the temperature dependence of the impact strength, resilience, and toughness of the heat cured and chemical cured acrylic denture base resins. Impact strength was examined using a impact testing machine. He concluded that impact strength may depend intensely on the motion of molecules as increase in temperature.

1)The impact strength of all the acrylic denture base resins tested were decreased with increase in temperature (23℃ to 60℃).

(2)There was a good association between the impact strength and the

quantity of the residual monomer The coefficient of correlation was-0.95 for the resilience, 0.92 for the impact strength and 0.94 for the toughness.

(3)In the chemical cured resins, the elastic modulus calculated from the result of the impact test increased with the time after polymerization.

(4)While chewing, the impact strength of denture base resins was very vulnerable to temperature change and or the residual monomer.

Levin B, et al(1989)[21]Demonstrated the importance of physical characteristics of microwave-cured resin are roughly the same as heat cured denture base resin cured.Their results showed no statistically significant differences between dentures cured by either method. The dentures cured by microwave energy has the benefits of reduced curing time, ease, and cleanliness.

Shlosberg SR, et al (1989)[22]Conducted several physical property tests to compare microwave energy and conventional thermal water bath curing techniques. Both the methods of polymerization produced similar dimensional accuracy in complete denture bases. No changes were found in transverse strength, Knoop hardness, density, and residual monomer content from the tested samples. No porosity was observed in removable partial denture bases and complete denture bases polymerized by either technique.

Uchida K et al (1989)[23] Compared the dimensional accuracy of microwave-cured denture base resin was with pour-type resin, heat-cured resin and heat-shock resin. From the test, the following results were obtained. Dimensional accuracy of microwave-cured denture base resin was better than that of heat-cured resin and heat-shock resin, and was similar to that of pour-type resin. Dimensional accuracy of microwave-cured denture base resin by slow cooling method was same with that rapid cooling method. These results suggest that microwave-cured denture base resin is better when compared to other type of resin in clinic.

Alkhatib MB et al (1990)[24]Compared the transverse strength, hardness and porosity of three denture base resins, two were processed with microwave energy and one

with thermal curing. No significant changes were found in transverse strength or hardness between the tested samples.

Bafile M et al (1991)[25]Compared porosity of microwave cured denture resin and heat cured denture base resin method. They concluded that no substantial differences were found in mean porosity between the four groups of microwave-cured resin the control group of methyl methacrylate monomer.

Sanders et al (1991)[26]Comparedthree denture base resin cured by water bath and by microwave energy. The adaptation of the record bases to a standard cast was measured to find if there were any significant changes in the fit that could be attributed to the differences in curing methods and the brands of resin. The results showed statistically significant difference for the heat cured resin generally, but clinically there were no appreciable differences in the adaptation of the record bases with both the resins. The adaptation of artificial dentures made from acrylic resin is clinically acceptable with either microwave curing or the water bath method.

Salim S et al (1992)[27]Evaluated the dimensional accuracy of acrylic resin specimens processed by three methods the SR- Ivocap system, conventional method, , and a microwave curing method. The dimensional accuracy was measured by the change of the distance vector V, which is calculated from the dimensions of the distances between fixed points on test specimens.The specimen cured by the conventional and the microwave curing methods is more than the SR-Ivocap system. But SR-Ivocap system shows a more accurate denture base than the conventional and the microwave cured resin.

S.G. Ilbay et al (1994)[28] Investigated the hardness, mechanical and physical properties of microwave cured denture base with respect to polymerization method,. Twenty-one different polymerization methods were used by varying watt power and curing time. The Vickers hardness test was used. Mechanical and physical tests were carried for testing the samples which were cured by the recommended polymerization method. The results showed that microwave cured acrylic resin cured is more resistant to mechanical failure than heat cured acrylic resin.

Polyzois GLet al (1995[29]) Measured the repair strength of denture base resins repaired with heat cured resin, microwave cured resin, and chemical cured resin. Transverse bend and impact strength tests were used for comparison. The results showed that the transverse strength and impact strength of the microwave cured resin specimens than others.

Vaidyanathan et al (1995)[30]Studied the clinical durability and performance of a denture fabricated from heat cured resin, microwave cured resin and light cured resin. Dynamic mechanical analysis was done using a flexural mode of deformation to characterize the viscoelastic properties of denture base resins. The results indicate that the microwave cured and heat cured resins are considerably different in their viscoelastic properties from the light cured denture base resins

May KB, Shotwell JR(1995)[31]Evaluated the color stability of seven conventional and one microwave processed heat cured denture base. The samples were exposed to conditions of accelerated aging to test for color stability. The results of this study showed that color changes for Hy-pro and TruTone materials exhibited the least color change.

Sadamori S et al (1997)[32]**S**tudied the influence of thickness on changes in a heat cured and microwave cured denture base resin. These findings suggested that the processing method and thickness of denture base resin determines the dimensional change of acrylic resin dentures and also affected by localized changes.

Vlissidis D et al (1997)[33] Investigated the effect of alcohol on the dynamic strength and static strength of denture base resin. Wetting tensile specimens with alcohol showed static strength by 16.1% and their fatigue strength by 14.3%. Polished specimens immersed in various concentrations over 40% alcohol revealed considerable surface corrosion which will reduce the fatigue strength of the denture base material.

T.Kanie et al(2000)[34]Determined the reinforcing effect of woven glass fibers on flexural strength deflection, flexural modulus and impact strength of acrylic denture base resin. Specimens were made by heating the denture cure resin dough containing glass fibers. Specimens with four different thicknesses and of five different types were made. He concluded that the impact strength for specimens reinforced with silanized glass fiber of 2 mm thickness was significantly higher than unreinforced test specimens. Reinforcing effect increased with the increase in number of glass fibers.

Mohammed Sohail and NorsiahYunus (2001)[35]Compared the impact and transverse strengths and the flexural modulus of a relatively new microwave-polymerized injection-molded polymer, conventional microwave cured denture resin and a heat cured resin. Impact strength was measured using a Charpy-type impact tester and the transverse strength and the flexural modulus were measured with a three-point bending test. The flexural modulus of the new denture material was higher than the heat-polymerized resin.

For impact and flexural strengths the microwave-polymerized, injection-molded, polyurethane-based polymer presented no significant change over the heat- and microwave cured denture base polymers.

Celia Marisa Rizzatti-Barbosa et al (2001)[36]Analyzed water sorption by polymerized acrylic resins under different pressure, temperature and time treatments. A heat cured acrylic resin was processed at 73 °C for nine hours. Among forty-five samples the control group samples were stored in a distilled water for 30 days, and specimen groups were placed in a curing device with adjustable pressure, time and temperature. He concluded that the alterations in temperature influenced the water sorption and pressure did not affect water sorption level.

Yannikakis S, Zissis A, et al (2002)[37]Investigated the effect of microwave energy on the porosity of heat-activated denture base resins. Conventional (Paladon 65) and microwave polymerization (Acron MC), were used for this study.The result showed minor porosity was identified in thin sections and more severe porosity in thicker areas of specimens that cured by microwave energy.

Radhwan H Hasanet al (2003)[38] Evaluated the porosity and transverse strength for microwave cured acrylic resin using new Iraqi micro wavable flask. For transverse strength test, 20 acrylic samples were prepared. Ten samples were processed by hot water bath technique, while the other 10 samples were prepared by microwave energy technique. Results showed no statistically significant differences.

GianlucaZappiniet al (2003)[39]Determined the fracture toughness of denture base resins and to compare the results with impact strength. Heat-polymerized denture base resins were chosen for this study .The result showed geometry of specimen and testing

configuration influenced the impact strength. The fracture toughness method appears to be more appropriate than impact strength measurements to determine the effects of resin modifications.

Keenan PL et al (2003)[40]Compared differences in dimensional changes of simulated maxillary complete dentures during polymerization and storage in water after injection molding, conventional polymerization, or microwave polymerization .In this study injection molding resulted in a slightly increase of vertical dimension of occlusion than conventional resin.

Azzarri MJet al (2003)[41]Evaluated the effect of the different conditions of curing on the residual monomer levels, impact strength, hardness of a microwave cured acrylic resin. The material was cured in a microwave oven in four different conditions of watt power and curing time. They concluded that from the appropriate selection of power and time of curing of the resin, it is probable to optimize the level of residual monomer with low cytotoxicity without altering the mechanical properties.

Marco Antonio Compagnoni et al (2004)[42]Evaluated the effect of different polymerization cycles on the porosity of a acrylic denture base resin intended for microwave polymerization. In this study, a denture base resin specifically intended for microwave polymerization was not affected by different polymerization cycles. The results suggest that microwave cured resin had the same level conventional water bath polymerized resin thus saved the processing time.

Keyf Fet al (2004)[43]Determined the gloss changes resulting from the testing process in four different beverages in heat-polymerized denture base resin and chemical cured denture base repair resin. The samples were immersed in water, tea, coffee, cola and cherry juice solutions. The samples was measured with the glossmeter at 45th day and 135th day of testing. It showed both are tested agents, and the four beverages demonstrated noticeable gloss changes. Cherry juice demonstrated the least change, while tea exhibited the greatest change.

C.-P. Lai , M.-H. Tsai , M. Chen et al(2004)[44]Examined the influence of microwave energy levels on the morphology and impact strength of denture base resin. Statistical differences was noted in morphology and flexural properties favor of the conventional water-bath method. Microwave power and polymerization time is significant in order to decrease porosity to a minimum level and increase the domain size and volume of the rubber phase.

Iara Augusta Orsiet al (2004)[45]The purpose of this study was to assess the effect of immersion in different chemical disinfectants for variable time periods on the transverse strength of chemically and mechanically polished heat-polymerized acrylic resins. Data were analyzed using ANOVA and Student t test. He concluded that the acrylic resins which was polished either mechanically or chemically did not demonstrate significant changes in transverse strength.

Thomas R.Meng et al (2005)[46] Determined the Izod impact strength, the flexural strength, the flexural modulus, and the yield distance for denture resins. Flexural strength, flexural modulus, and yield distance were tested using a three-point test. Izod impact

strength was determined using an Izod tester on un-notched specimens. He concluded that Flexural modulus had an inverse relationship to the impact strength, flexural strength, and yield distance.

Fernanda Faotet al (2006)[47]This study evaluated the impact strength and fracture morphology of denture base acrylic resins processed by microwave energy and hot water bath. The impact strength was evaluated in an impact testing machine using the Charpy method. Acrylic resins exhibited a high number of brittle fractures irrespective of the processing technique.

Camilo Machado (2007)[48]This study was carried out to compare the transverse strength of three denture base materials, namely heat cured resin Lucitone 199 and light cured resin(Triad VLC, Eclipse). The transverse strength values showed substantial differences between the three denture base materials. Eclipse showed the highest transverse strength among the materials tested. Thus it may provide a better alternative to traditional denture base resins.

Rosangela et al(2007) [49]Evaluated the effect of hot water and microwave post-polymerization treatments on the flexural strength and Vickers hardness of four chemical reline resins and heat-polymerized acrylic resin. He took thirty specimens for each material and divided into 3 groups Data were analyzed by two-way ANOVA followed by Tukey's HSD test. He concluded that the hardness of the tested materials was not influenced by the post-polymerization treatments and used to improve the flexural strength.

Al- Nori and RejabLT(2007)[50] Evaluated the effect of the different curing methods and different immersion periods on the water sorption and solubility of the

different types of heat–cured acrylic resins .Water sorption and solubility were measured by means of mass change in the materials after water saturation and dehydration. It showed that curing method and immersion period have a significant effect on the water sorption and solubility ratios of the resins. Curing by microwave energy method and increasing immersion period caused increasing in the ratios. The type of heat–cured acrylic resin has an effect but the difference was not significant.

Débora Barros Barbosa (2007)[51] Evaluated the influence of microwave polymerization on the flexural strength of a conventional heat-polymerized, a microwave polymerized and a auto polymerizing acrylic resins. The microwave polymerized resin showed the highest means for flexural strength and there were no significant differences among them. The heat-polymerized group showed the lowest flexural strength means ,and differ significantly from all groups.

RejabL (2008)[52] Evaluated the effect of the thermo press curing technique on the water sorption and solubility of the chemical–cured and heat cured acrylic resins He compared with the bench curing technique used for the cold cured resin and with the conventional water bath curing technique for the heat cured resin. There is a significant differences between the water sorption and solubility of resin that cured by the different curing methods and different curing cycle times. The water sorption and solubility of resin specimens that cured by thermo press have the higher values. And also curing under higher pressure produces specimens with lower water sorption and solubility values.

Mithaq R. Mohammed (2008)[53] The aim of this study was to compare the effect of chlorehexidine and sodium hypochlorite as a disinfectant solutions on the surface roughness of different denture base material. The result of this study indicated that the

roughness of acrylic materials was not affected by immersion in any disinfectant solution this is due to the effect of glutaraldehyde base disinfectants (alkaline, phenol buffered) on surface morphology of denture base resin and also the disinfectant solution was able to reduce the pathogenicity and colorization of micro organism present on the surface of the material.

Nadia A et al (2008)[54] Conducted the two folded study: an in vivo study aimed to compare between the clinical efficiency of heat-cured and microwave-cured over denture bases, In-vitro study to relate the chemical, physical and mechanical properties, to the clinical performance of these over dentures. In vivo study the mandibular over dentures were weighed and their thicknesses were measured at predetermined fixed points on denture bases. In-vitro study result showed that heat cured acrylic resins exhibited higher wear resistance, and also their over denture bases showed decreased in weight in contrast to microwave cured bases which showed slight increase in weight and decrease in wear resistance over the follow up periods.

Ana M. Diaz-Arnold et al (2008)[55] Evaluated the static and dynamic flexure properties of a heat-polymerized resin and visible light cured resins. The visible light-polymerized urethane dimethacrylate resin showed greater flexural strength than all heat-polymerized resins for both static and cycled groups. The Eclipse material had lower load limits, and demonstrated brittle-type behavior.

SuleymanHakan Tuna et al (2008)[56] Studied heat cure resin and chemical cured resin to evaluate water sorption and water solubiity. The results of the water sorption and water solubility values of both chemical-cured and heat-cured acrylic resins were in

harmony with the ISO specification. No correlation found between water sorption and water solubility values.

Helena de Freitas Oliveira (2009)[57]Evaluated the color stability, surface roughness and flexural strength of a microwave-polymerized acrylic resin after immersion in sodium hypochlorite (NaOCl), simulating 20 min of disinfection daily during 180 days. The flexural strength was measured using a 3-point bending test in a universal testing machine. He concluded that immersion in NaOCl solutions simulating short-term daily use during 180 days did not influence the color stability, surface roughness and flexural strength of a microwave-polymerized acrylic resin.

Fernanda Faot, Leonardo H V Panza, (2009)[58] Evaluate the impact and flexural strength and analyzed the fracture behavior of various heat cured acrylic resins. The impact strength was evaluated in notched specimens and flexural strength in unotched specimens. Fragments from mechanical tests were observed by SEM. Impact resin showed improved mechanical properties with high capacity of stress absorption and energy dissipation before fracture than conventional heat cure resin.

Mohammed NZ (2010)[59]Determined the effect of thickness and additives such as Nigella Stavia oil and Thymol oil on water sorption and solubility of heat cured acrylic resin denture base. Additive materials (0.5%) each of Nigella Stavia oil and Thymol oil were added . Water sorption and solubility of specimens were measured by mean of mass change in material after water saturation and dehydration. Increase thickness causes decrease in water sorption and solubility.

Rajlakshmi Banerjee and Sujoy Banerjee (2010)[60] Compared the flexural fatigue strength of denture base resins polymerized by the conventional water bath, microwave, and pressure cooker polymerization techniques. Flexural fatigue strength were measured using a cyclic 3-point loading method on a dynamic universal testing machine. Flexural fatigue strength of samples processed by hot water bath processing and the microwave technique showed statistically significant results. He concluded that polymerization procedure plays important role in influencing the flexural fatigue strength of denture base resins.

Rola W. Abdul-Razaqet al (2011)[61]Investigated the effect of Pepsi solution on tensile bond strength with and without surface treatment of the denture base material. The results revealed that there was no significant difference in tensile bond strength, for all test specimens stored in water while there was highly significant difference for the test specimens stored in Pepsi.

Pooran Chand, Chandra Bhusan Singh Patel(2011)[62] Evaluated the transverse deflection and transverse strength of four commercial brands of heat cure acrylic resin using Instron testing machine. Trevalon "HI" also had minimum value of mean transverse strength among different brands of acrylic resins. There was no statistically significant difference between Stellon, Acrylin-H and Trevalon. The heat cure denture base material D (Trevalon "HI") was the strongest and C (Trevalon) was the weakest among all materials used in this study.

Amanda FucciWady (2011)[63]Studied the effect of water storage on the impact strength of one denture base and four reline resins. Specimens were evaluated with

Charpy impact test after immersion in water for 7, 90 and 180 days. Result showed difference in Impact strength values for acrylic resins when immersed in Water at inconstant time and also suggested that adhesion between the denture base and reline materials at their interface may influence the resistance to fracture of relined denture bases.

Hae-Hyoung LEE, Chung-Jae LEE(2012)[64] Measured various mechanical properties including flexural modulus, flexural strength, fracture toughness, Barcol and Vickers hardness and correlations between them. Data from the mechanical tests were examined using correlation tests. The flexural modulus value showed reasonable positive association with those of proportional limit, flexural strength, and surface hardness.

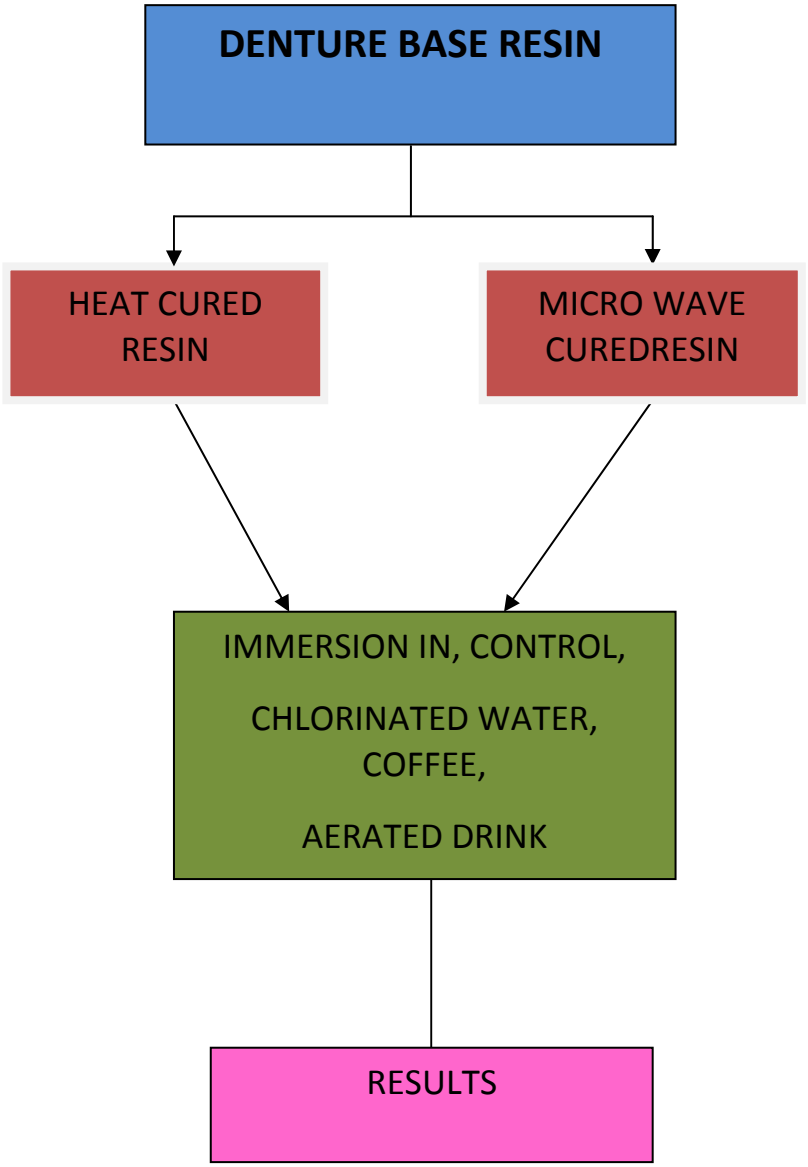
MATERIALS AND METHODOLOGY

MATERIALS AND METHODS

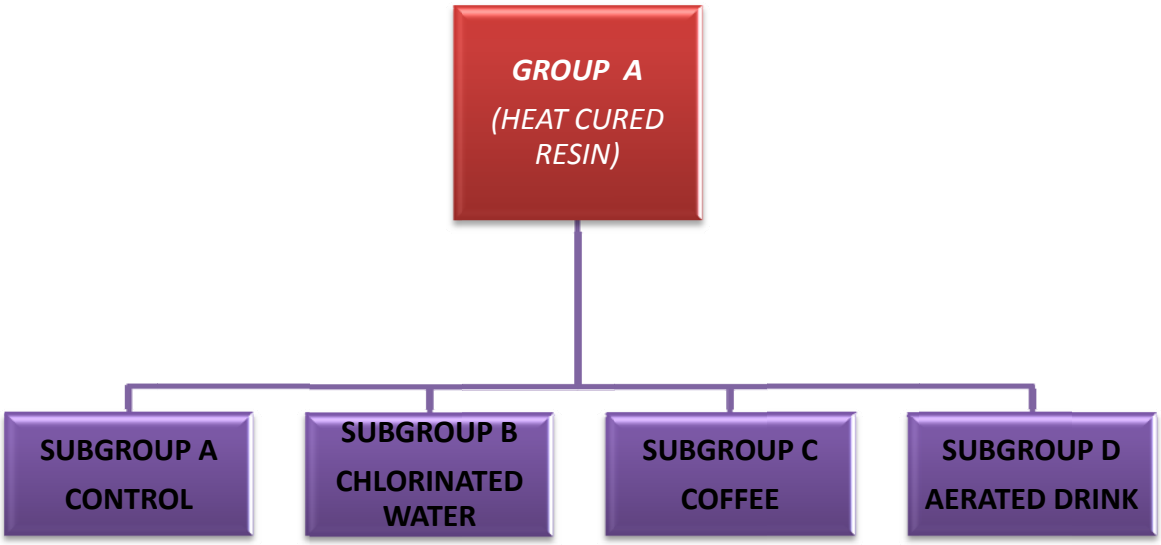
The present study was conducted to evaluate the effect of different liquids consumed by the common man in his routine life on the impact and flexural strength of heat cured and microwave cured acrylic resins. The materials and the armamentarium used in this study were shown below.

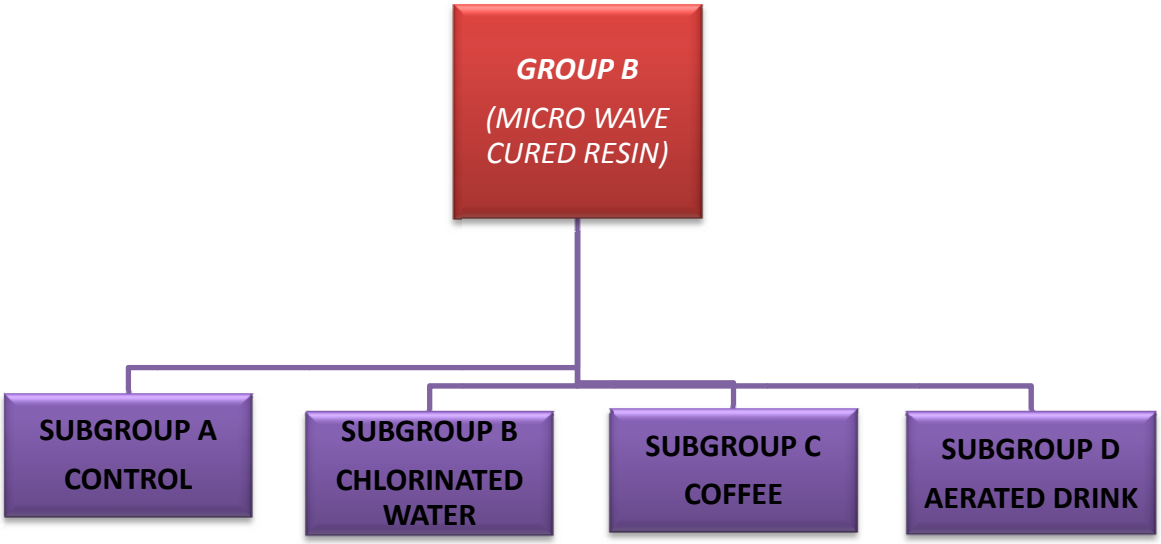
S.NO	NAME OF THE MATERIAL	COMMERCIAL NAME	MANUFACTURER
1	Heat polymerizing poly methyl methacrylate resin	Hi flex	Hi flex,Prevest DenproLtd,INDIA
2	Micro wave resin	EC –CRYL	(EC –CRYL) Private Ltd, Columbia
3	Aerated drink	Coca –cola	Hindustan Coca –cola beverages,INDIA
4	Coffee	Nescafe	Nestle,Private Ltd INDIA.
5	Chlorinated water		

STUDY DESIGN



FLOWCHART:


GROUP A
(HEAT CURED RESIN)
SUBGROUP A
CONTROL
SUBGROUP B
CHLORINATED WATER
SUBGROUP C
COFFEE
SUBGROUP D
AERATED DRINK


GROUP B
(MICRO WAVE CURED RESIN)
SUBGROUP A
CONTROL
SUBGROUP B
CHLORINATED WATER
SUBGROUP C
COFFEE
SUBGROUP D
AERATED DRINK

The table showing immersion media used in the present study showing the quantity generally used for single use, approximate time spent for single use and the duration adopted which is equivalent to three years.

Solution	Amount consumed /day	Approx. time spent/dose	Duration equivalent to 3 years
Chlorinated water	1 litre	1 min	18 hours
Coffee	120 ml	3 min	55 hours
Aerated drink	300 ml	5 min	91 hours

Armamentarium used for the study

1. Custom fabricated stainless steel dies
2. Glass plate
3. Rubber bowl
4. Plaster mixing Spatula
5. Camel hair brush
6. Bard Parker knife
7. Conventional metallic flasks with clamp
8. Cement mixing stainless steel spatula
9. Porcelain jar
10. Fibre reinforced Plastic flask
11. Metallic flask(brass)
12. Acrylizer
13. Acrylic trimmers
14. Tungsten carbide bur
15. Micro motor
16. Silicon carbide paper
17. Micro motor

PREPARATION OF THE SAMPLES & GROUPING:

The samples for this in vitro study was prepared according to ISO specification (1567).A total number of 160 samples were prepared with dimension of 80x10x3millimetre.Out of which 80 samples were prepared from heat cured acrylic resin (group A) and the other 80 samples were prepared from micro wave cured resin (group B).Each category of acrylic resin and microwave polymerization were again divided into four sub groups as follows sub group I, II, III, IV. The group I samples were used as control group. Twenty samples were allotted for each sub group out of which 10 samples were taken up from (group A) and another 10 samples were taken from

(group B).

PREPARATION OF STAINING SOLUTIONS

The coffee solution was prepared by adding 20g of coffee powder (Nestle India LTD, New Delhi ,India) into 1000ml of boiled distilled water and stirred until they cooled down to 37^0C and then poured into a jar. Aerated drink (Hindustan Coca cola Beverages Private LTD, India) and Chlorinated water are poured into separate jar and the acrylic specimens fabricated were immersed in the solutions respectively.

PREPARATION OF TEST SAMPLES

A rectangular steel die was milled from a metal blank measuring 80x10x3 mm to simulate the bar .This steel die bar was used to create a stone mold by investing in a type III dental stone (Kalabhai, Mumbai, India) according to manufacturer's instruction.

Stone mold was separated and trimmed to remove the excess, mold was filled with modeling wax then invested in conventional dental flask with type II plaster (White

gold Asian chemicals, Mumbai). After dewaxing procedure, heat cured acrylic resin samples were prepared in a usual manner following the normal processing procedure.

According to manufacturer's instructions powder and liquid were taken in a ratio of 3:1by volume. First the monomer is poured into a porcelain jar, powder was added in slow steady manner until dry powder appears on the surface. Then the jar was tapped for 4-5 times until the saturation of both powder and liquid .Then the mix was thoroughly mixed with spatula for 1 minute, then the jar was closed until the dough stage to reach.[13]When the dough stage was reached, the resins were packed into the molds by compression molding technique. After trial packing the flasks were closed and allowed for bench curing for 30 minutes.[14]

Samples of resin were cured at 70 degree centigrade for one and half hours followed by terminal boiling for one hour. After processing all of the flasks were allowed to bench cool for 30 minutes, followed by immersion in running water for 15 minutes. After deflasking the rectangular resin samples were retrieved from the mold and immersed in distilled water at 37 ± 1°C for 50 ± 2 hours for residual Flash and excess resin were removed and trimming was done with aluminium carbide acrylic trimmers. Each specimen were finished using 600, 800 grit silicon carbide paper and polished with pumice slurry.

For micro wave cured resin the stone mold with wax pattern was invested in a plaster and stone mix 50% of each according to manufacturer's instructions in a polycarbonate flask reinforced with fiber glass[15], after the setting of plaster separating media petroleum jelly was applied over stone mold. Then the flask is closed by replacing counterpart. Dewaxing was done in microwave oven at 750 watt for a period of one minute. After loosening the check screw, the flask was removed and was placed the wet

cotton and again kept in oven for 1 minute for the removal residual wax, Later the flask was allowed to bench cool for 10 min, then the isolant was applied over the mold space.[16]

According to the manufacturer's instructions 23.5gms of powder and 10 ml of liquid were taken, the monomer is poured into a porcelain jar then powder was added in slow steady manner until dry powder appears on the surface. Then the jar was tapped for 4-5 times until the saturation of both powder and liquid. Then the mix was thoroughly mixed with spatula for one minute, then the jar was closed to reach the dough stage. When the dough stage was reached, the resins were packed into the molds with 2 bar/pressure after trial packing the screw was tightened.[16]

Calibration of microwave oven

Micro wave resin with turning table were used for even distribution of microwave energy over flask with 10% increment in adjustment, it is calibrated for processing by keeping 1 liter of water at room temperature in the oven allow to raise in temperature by 2 degree in 1 min then it is calculated for percentage.

After calibration the polycarbonate flask was kept in oven for nine minutes at 750 Watts. Micro wave oven should not be opened for next 10-15 minutes since secondary microwave energy will act on it afterwards the flask was removed and immersed in water at room temperature for 10 minutes. Then specimens were recovered with plastic hammer or horn mallet and immersed in distilled water at 37 ± 1°C for 50 ± 2 hours for residual monomer release.[16,17]

The specimens were trimmed using stones, trimmers and finished by 400,600,800 grit sand papers pumice slurry was used for polishing for the specific dimensions of 80x10x3mm as specified by ISO specifications.

In each subgroup,10 specimens were tested for impact strength, flexural strength for three different medium for both heat cure resin and microwave cured resin after immersion in different media.

All the prepared specimens were then subjected for Impact strength, Flexural strength tests in the testing machine.

Impact strength of the acrylic resin was calculated using 300 joules capacity impact testing machine (Notched Impact Tester ASTM D-256, Tinius Olsen USA). Impact strength was tested by the Charpy system .when the hammer of the impact testing machine hits the specimen, reading at which the specimen breaks gives the impact strength it is the pendulum type and the impact strength values were obtained directly in the machine scale. mpact strength was expressed in gram force-centimeter (gf-cm).

For flexural strength the specimens were submitted to 3-point bending test in a universal testing machine (Shimadzu Tokyo JAPAN) with a maximum capacity of 50 kilo newton and cross cut speed of 1.3millimetre/min. The flexural strength value was obtained using the formula

$F=3WL/2bd^2$

Where F=flexure strength

W=ultimate load before the failure (KN)

L=distance between the support points (50 mm)

b=specimen width (10 mm)

d=specimen thickness (3 mm)

Results were obtained in Mpa by multiplying the values in KN/mm^2 by the constant 1000.

FIG- I HEAT CURE DENTURE BASE RESIN

FIG- 2 MICROWAVE CURE DENTURE BASE RESIN

FIG- 3 ARMAMEMENTARIUM

FIG- 4 STEEL METAL DIE

FIG- 5 FLASKING FOR HEAT CURE

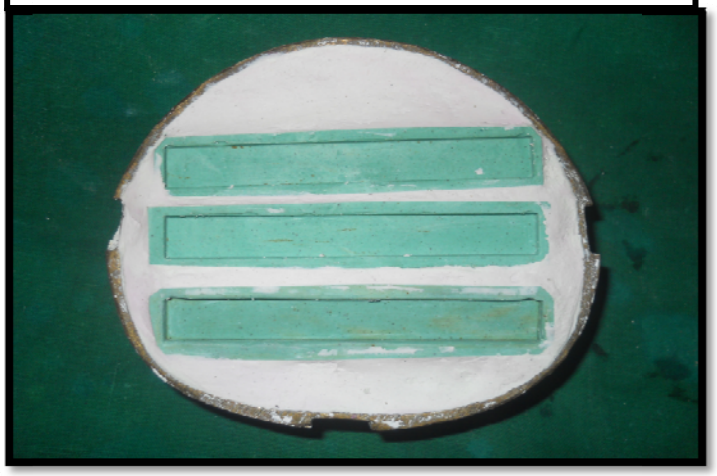


FIG- 6 FLASKING FOR MICRO WAVE CURERESIN

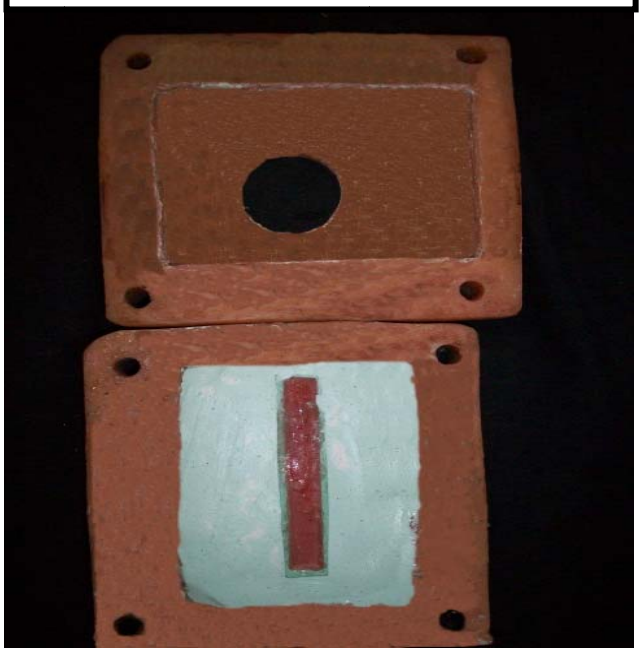
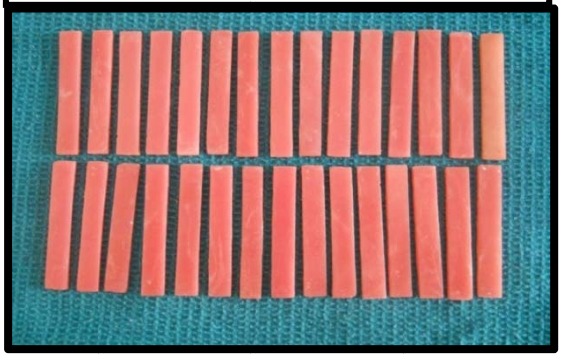


FIG- 7 ACRYLISER

FIG- 8 MICRO WAVE OVEN

FIG- 9 HEAT CURED RESIN

FIG- 10 MICRO WAVECURED RESIN SPECIMEN



SPECIMEN IMMERSION

FIG- 11 CONTROL

FIG- 12 CHLORINATED WATER

FIG- 13 COFFEE

FIG- 14 AERATED DRINK

FIG- 15 UNIVERSAL TESTING MACHINE

FIG- 16 SPECIMEN UNDER LOAD

FIG- 17 IMPACT NOTCH CUTTER

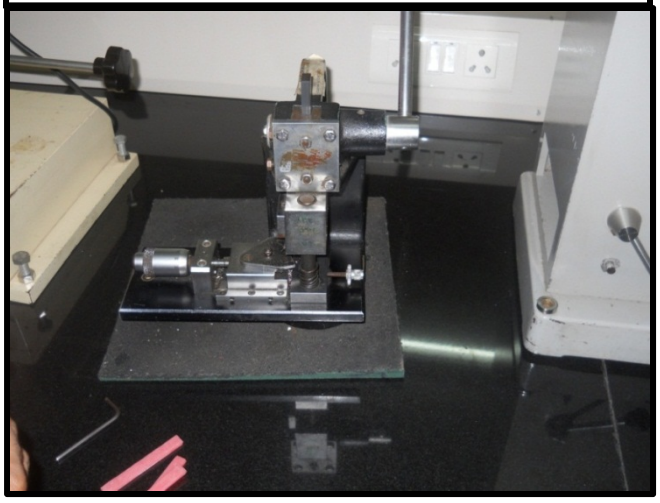


FIG- 18 CHARPY IMPACT TESTER

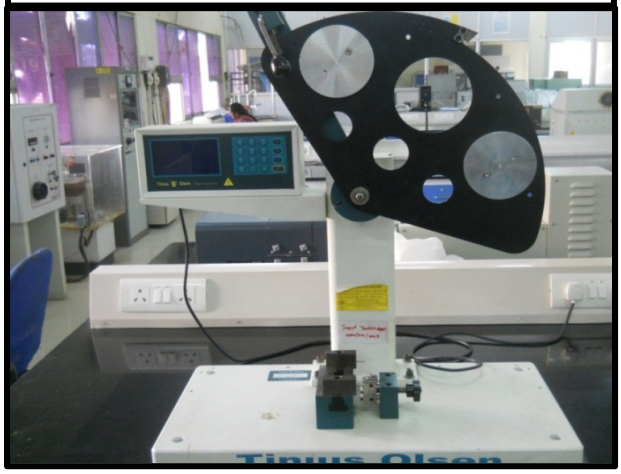


FIG- 19 SPECIMEN UNDER IN SITU

RESULTS

This study was performed to evaluate the mechanical properties of heat cured and micro wave cured denture base resin after immersing in different fluids routinely used in day to day life.

The results were obtained after subjecting the samples to a universal testing machine for flexural strength and Charpys impact tester for impact strength. In this study the denture base resins were grouped into A, and B .For each group four observations were made for control, chlorinated water, coffee, and aerated drink. The basic data of the results are shown in Annexure.

Results of this study are shown below

Table 1 shows the mean value, standard deviation using ANOVA test for group A. for flexural strength.

Table 2 shows the mean value, standard deviation using ANOVA test for group B for flexural strength.

Table 3 shows the p value using ANOVA test for group A for flexural strength.

Table 4 shows the p value using ANOVA test for group B for flexural strength.

Table 5 shows paired t test comparing the flexural Strength of Sub Groups in Group A using Tukey HSD Post Hoc Tests.

Table 6 shows paired t test comparing the flexural Strength of Sub Groups in Group B using Tukey HSD Post Hoc Tests.

Table 7 shows independent sample T-Test for comparison of Flexural strength between the Groups (A& B).

Table 8 shows the mean value, standard deviation using ANOVA test for group A. for Impact strength.

Table 9 shows the mean value, standard deviation using ANOVA test for group B for impact strength.

Table 10 shows the p value using ANOVA test for group A for impact strength.

Table 11 shows the p value using ANOVA test for group B for impact strength.

Table 12 shows paired t test comparing the Impact Strength of Sub Groups in Group A using Tukey HSD Post Hoc Tests.

Table 13 shows paired t test comparing the Impact Strength of Sub Groups in Group B using Tukey HSD Post Hoc Tests.

Table 14 shows independent sample T-Test for comparison of Impact strength between the Groups (A& B).

Bar diagram 1 shows comparison of sub groups in group A for Flexural strength.

Bar diagram 2 shows comparison of sub groups in group B for Flexural strength.

Bar diagram 3 shows inter comparison of group A and B for Flexural strength.

Bar diagram 4 shows comparison of sub groups in group A for Impact strength.

Bar diagram 5 shows comparison of sub groups in group B for Impact strength.

Bar diagram 6 shows inter comparison of group A and B for Impact strength.

Bar diagram 7 shows inter comparison of group A and B for Flexural strength and Impact strength

Group A FLEXURAL STRENGTH

Table 1 shows the mean value, standard deviation using ANOVA test for group A

S.NO	SUB GROUP	N	MEAN	SD
1.	Control	10	74.60	6.60
2.	Chlorinated water	10	74.58	5.74
3.	Coffee	10	74.40	6.96
4.	Aerated Drink	10	65.31	5.74

Group B FLEXURAL STRENGTH

Table 2 shows the mean value, standard deviation using ANOVA test for group B

S.NO	SUB GROUP	N	MEAN	SD
1.	Control	10	84.30	8.47
2.	Chlorinated water	10	81.90	6.37
3.	Coffee	10	81.86	6.54
4.	Aerated Drink	10	71.49	6.26

Table 3 shows the p value using ANOVA test for group A for flexural strength,

S.NO	SUB GROUP	N	MEAN	SD
1.	Control	10	74.60^{b}	6.60
2.	Chlorinated water	10	74.58^{b}	5.74
3.	Coffee	10	74.40^{b}	6.96
4.	Aerated Drink	10	65.31^{a}	5.74
F Ratio = 5.390				
P Value<o.oo5				

Note:

If P value is 0.000 to 0.010 then denoted by ** => Significant at 1 % level

If P value is 0.011 to 0.050 then denoted by * => Significant at 5 % level

Different alphabets between groups denote significance at 5% as per post hoc test TukeyHSD.The subsets are denoted by alphabets and the alphabets denote values in increasing order.

(Note is common for tables 3,4 and 10,11)

Table 4 shows the p value using ANOVA test for group B for flexural strength.

S.NO	SUB GROUP	N	MEAN	SD
1.	Control	10	84.30[b]	8.47
2.	Chlorinated water	10	81.90[b]	6.37
3.	Coffee	10	81.86[b]	6.54
4.	Aerated Drink	10	71.49[a]	6.26
F Ratio = 6.727				
P Value<o.oo1				

Table 5 shows paired t test comparing the flexural Strength of sub Groups in Group A using Tukey HSD Post Hoc Tests

(I) Sub Group	(J) Sub Group	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Control	Chlorinated water	-.19695	2.8097	1.000	-7.764371	7.370471
	Coffee	-.17765	2.8097	1.000	-7.745071	7.389771
	Aerated Drink	9.0980(*)	2.8097	.013	1.531399	16.666241
Chlorinated water	Control	.196950	2.8097	1.000	-7.370471	7.764371
	Coffee	.019300	2.8097	1.000	-7.548121	7.586721
	Aerated Drink	9.2950(*)	2.8097	.011	1.728349	16.863191
Coffee	Control	.177650	2.8097	1.000	-7.389771	7.745071
	Chlorinated water	-.019300	2.8097	1.000	-7.586721	7.548121
	Aerated Drink	9.2764(*)	2.8097	.011	1.709049	16.843891
Aerated Drink	Control	-9.0980(*)	2.8097	.013	-16.666241	-1.531399
	Chlorinated water	-9.2950(*)	2.8097	.011	-16.863191	-1.728349
	Coffee	-9.2760(*)	2.8097	.011	-16.843891	-1.709049

* The mean difference is significant at the .05 level.

Table 6 shows paired t test comparing the flexural Strength of sub Groups in Group B using Tukey HSD Post Hoc Tests

(I) Sub Group	(J) Sub Group	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Control	Chlorinated water	2.3929	3.1159	.868	-5.999078	10.785018
	Coffee	2.4333	3.1159	.863	-5.958778	10.825318
	Aerated Drink	12.809(*)	3.1159	.001	4.417322	21.201418
Chlorinated water	Control	-2.3929	3.1159	.868	-10.785018	5.999078
	Coffee	.040300	3.1159	1.000	-8.351748	8.432348
	Aerated Drink	10.416(*)	3.1159	.010	2.024352	18.808448
Coffee	Control	-2.4332	3.1159	.863	-10.825318	5.958778
	Chlorinated water	-.04030	3.1159	1.000	-8.432348	8.351748
	Aerated Drink	10.376(*)	3.1159	.010	1.984052	18.768148
Aerated Drink	Control	-12.809*)	3.1159	.001	-21.201418	-4.417322
	Chlorinated water	-10.416(*)	3.1159	.010	-18.808448	-2.024352
	Coffee	-10.370(*)	3.1159	.010	-18.768148	-1.984052

* The mean difference is significant at the .01 level.

Table 7 shows independent sample T-Test for comparison of Flexural strength between the Groups (A& B)

Flexural Strength		Levene's Test for Equality of Variances	t-test for Equality of Means							
		F	Sig.	T	df	Sig (2tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
(Control)	Equal variances assumed	.113	.741	-2.85	18	.011	-9.89	3.46	-17.17	-2.6
	Equal variances not assumed			-2.85	17.3	.011	-9.89	3.46	-17.19	-2.58
(Chlorinated water)	Equal variances assumed	.099	.757	-2.51	18	.021	-7.30	2.9	-13.39	-1.2
	Equal variances not assumed			-2.51	17.9	.021	-7.3	2.9	-13.39	-1.2
(Coffee)	Equal variances assumed	.152	.701	-2.64	18	.016	-7.28	2.75	-13.06	-1.5
	Equal variances not assumed			-2.6	17.7	.017	-7.28	2.75	-13.06	-1.4
(Aerated Drink)	Equal variances assumed	.032	.859	-2.3	18	.033	-6.18	2.68	-11.82	-.53
	Equal variances not assumed			-2.3	17.8	.034	-6.18	2.68	-11.82	-.53

* The mean difference is significant at the .05 level.

GROUP A IMPACT STRENGTH

Table 8 shows the mean value, standard deviation using ANOVA test for group A

S.NO	SUB GROUP	N	MEAN	SD
1.	Control	10	26.35	2.97
2.	Chlorinated water	10	24.58	1.41
3.	Coffee	10	24.55	1.88
4.	Aerated Drink	10	18.50	2.15

GROUP B IMPACT STRENGTH

Table 9 shows the mean value, standard deviation using ANOVA test for group B

S.NO	SUB GROUP	N	MEAN	SD
1.	Control	10	30.14	1.69
2.	Chlorinated water	10	28.62	6.59
3.	Coffee	10	28.45	1.30
4.	Aerated drink	10	23.58	1.53

Table 10 shows the p value using ANOVA test for group A for Impact strength

S.NO	SUB GROUP	N	MEAN	SD
1.	Control	10	26.35^{b}	2.97
2.	Chlorinated water	10	24.58^{b}	1.41
3.	Coffee	10	24.55^{b}	1.88
4.	Aerated Drink	10	18.50^{a}	2.15
F Ratio 24.799				
P Value<o.oo5				

Table 11 shows the p value using ANOVA test for group B for Impact strength,

S.NO	SUB GROUP	N	MEAN	SD
1.	Control	10	30.14[b]	1.69
2.	Chlorinated water	10	28.62[b]	6.59
3.	Coffee	10	28.45[b]	1.30
4.	Aerated Drink	10	23.58[a]	1.53
F Ratio 6.442				
P Value<o.oo1				

Table 12 shows paired t test comparing the Impact Strength of sub Groups in Group A using Tukey HSD Post Hoc Tests

(I) Sub Group	(J) Sub Group	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Control	Chlorinated water	1.7695	.97489	.283	-.856090	4.395150
	Coffee	1.7963	.97489	.271	-.829280	4.421960
	Aerated Drink	7.845(*)	.97489	.000	5.219530	10.470770
Chlorinated water	Control	-1.7695	.97489	.283	-4.395150	.856090
	Coffee	.026810	.97489	1.00	-2.598810	2.652430
	Aerated Drink	6.0756(*)	.97489	.000	3.450000	8.701240
Coffee	Control	-1.7963	.97489	.271	-4.421960	.829280
	Chlorinated water	-.02681	.97489	1.000	-2.652430	2.598810
	Aerated Drink	6.0488(*)	.97489	.000	3.423190	8.674430
Aerated Drink	Control	-7.8450(*)	.97489	.000	-10.470770	-5.219530
	Chlorinated water	-6.0750(*)	.97489	.000	-8.701240	-3.450000
	Coffee	-6.0410(*)	.97489	.000	-8.674430	-3.423190

* The mean difference is significant at the .01 level.

Table 13 shows paired t test comparing the Impact Strength of sub Groups in Group B using Tukey HSD Post Hoc Tests

(I) Sub Group	(J) Sub Group	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Control	Chlorinated water	-.16346	1.5860	1.00	-4.434978	4.108058
	Coffee	-1.6916	1.5860	.712	-5.963208	2.579828
	Aerated Drink	4.8666(*)	1.5860	.020	.595142	9.138178
Chlorinated water	Control	.16346	1.5860	1.000	-4.108058	4.434978
	Coffee	-1.5282	1.5860	.771	-5.799748	2.743288
	Aerated Drink	5.0301(*)	1.5860	.016	.758602	9.301638
Coffee	Control	1.6916	1.5860	.712	-2.579828	5.963208
	Chlorinated water	1.52823	1.5860	.771	-2.743288	5.799748
	Aerated Drink	6.5583(*)	1.5860	.001	2.286832	10.829868
Aerated Drink	Control	-4.8666(*)	1.5860	.020	-9.138178	-.595142
	Chlorinated water	-5.0301(*)	1.5860	.016	-9.301638	-.758602
	Coffee	-6.5583(*)	1.5860	.001	-10.829868	-2.286832

* The mean difference is significant at the .05 level.

* The mean difference is significant at the .01 level.

Table 14 shows Independent sample un paired T-Test for comparison of Impact strength between the Groups (A& B)

Impact Strength		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Control	Equal variances assumed	5.57	.030	-1.94	18	.067	-2.10	1.08	-4.37	.166
	Equal variances not assumed			-1.94	14.2	.071	-2.10	1.08	-4.41	.209
Chlorinated Water	Equal variances assumed	31.5	.000	-1.89	18	.074	-4.03	2.13	-8.51	.439
	Equal variances not assumed			-1.89	9.81	.088	-4.03	2.13	-8.79	.722
Coffee	Equal variances assumed	1.10	.307	-7.73	18	.000	-5.59	.723	-7.11	-4.07
	Equal variances not assumed			-7.73	16.0	.000	-5.59	.723	-7.12	-4.05
Aerated drink	Equal variances assumed	2.11	.163	-6.08	18	.000	-5.08	.835	-6.83	-3.32
	Equal variances not assumed			-6.08	16.2	.000	-5.08	.835	-6.85	-3.31

* The mean difference is significant at the .01 level.

Statistical analysis of the results

The collected data for the heat cured resin and micro wave cured resin were analyzed using SPSS 16.000 Software. To describe the descriptive statistics mean, standard deviation were used. The overall group comparison was done using one-way ANOVA (Analysis of Variance) with a significant level of 1% followed by inter group comparison which was done using multiple comparison post hoc TUKEY HSD test with a significant level of 5%.To find significance paired T test between the groups were used.

Table I – shows the mean and standard deviation of flexural strength for the heat cured polymerized resin. On evaluation the specimens immersed in aerated drink show decreased flexural strength of 65.31 Mpa and standard deviation of 5.74 and control specimen show maximum value of flexural strength of 74.60 Mpa and standard deviation of 6.60 .

Table 2 – shows the mean and standard deviation of flexural strength for the micro wave cured polymerized resin. On evaluation the specimens immersed in aerated drink show decreased flexural strength of 71,49 Mpa and standard deviation of 6,75 control shows maximum value of flexural strength of 84.30 Mpa and standard deviation of 8.47.

Table 3 shows statistical analysis of Variance One-way Anova between sub groups of heat cured resin. It shows p value(<0.001) is significant at 1% level, the inter

group comparison at a significance level of 5% shows that sub group A1,A2,A3 are significantly different from A4,which means that A1,A2,A3 has higher values than A4.

Hence the specimens immersed in aerated drink has the lowest flexural strength value followed by coffee, chlorinated water and control sub group in increasing order.

Table 4 shows statistical analysis of Variance One-way Anova between sub groups of micro wave cured resin. It shows p value(<0.001) is significant at 1% level, the inter group comparison at a significance level of 5% shows that sub group B1,B2,B3 are significantly different from B4,which means that B1,B2,B3 has higher values than B4.

Hence the specimens immersed in aerated drink has the lowest flexural strength value followed by coffee, chlorinated water and control sub group in increasing order.

Table 5 shows paired t test comparing the flexural Strength of sub groups of heat cured resin using Tukey HSD Post Hoc Tests. It shows p value is significant at level of 5% for the specimens immersed in Aerated drink.

Hence the specimens immersed in aerated drink has lowest flexural strength value than other sub groups

Table 6 shows paired t test comparing the flexural Strength of sub groups of heat cured resin using Tukey HSD Post Hoc Tests. It shows p value is significant at level of 1% for the specimens immersed in Aerated drink.

Hence the specimens immersed in aerated drink has lowest flexural strength value than other sub groups

Table 7 shows independent sample T-Test comparing the flexural strength between the heat cured resin and micro wave cured resin. It shows p value is significant at level of 5% for the specimens immersed in Aerated drink.

Hence, the specimens immersed in aerated drink has lowest flexural strength value than other sub groups.

Table 8 shows the mean and standard deviation of Impact strength for the micro wave cured polymerized. On evaluation the specimens immersed in aerated drink show decreased Impact strength of 18.50 Mpa and standard deviation of 2.15 control shows maximum value of Impact strength of 26.35 Mpa and standard deviation of 2.97.

Table 9 shows the mean and standard deviation of Impact strength for the micro wave cured polymerized resin. On evaluation the specimens immersed in aerated drink show decreased Impact strength of 23.58 Mpa and standard deviation of 1.53 control shows maximum value of Impact strength of 30.14 Mpa and standard deviation of 1.69.

Table 10 shows statistical analysis of Variance One-way Anova between sub groups of heat cured resin. It shows p value (<0.001) is significant at 1% level, the inter group comparison at a significance level of 5% shows that sub group A1,A2,A3 are significantly different from A4,which means that A1,A2,A3 has higher values than A4.

Hence,the specimens immersed in aerated drink has the lowest Impact strength value followed by coffee, chlorinated water and control sub group in increasing order.

Table 11 shows statistical analysis of Variance One-way Anova between sub groups of micro wave cured resin. It shows p value(<0.001) is significant at 1% level, the

inter group comparison at a significance level of 5% shows that sub group B1,B2,B3 are significantly different from B4,which means that B1,B2,B3 has higher values than B4.

Hence, the specimens immersed in aerated drink has the lowest Impact strength value followed by coffee, chlorinated water and control sub group in increasing order.

Table 12 shows paired t test comparing the Impact Strength of sub groups of heat cured resin using Tukey HSD Post Hoc Tests. It shows p value is significant at level of 1% for the specimens immersed in Aerated drink.

Hence, the specimens immersed in aerated drink has lowest Impact strength value than other sub groups.

Table 13shows independent sample T-Test comparing the impact strength between the heat cured resin and micro wave cured resin. It shows p value is significant both at 1% and 5% level for the specimens immersed in Aerated drink.

Hence, the specimens immersed in aerated drink has lowest Impact strength value than other sub groups.

Table 14 shows independent sample T-Test comparing the Impact strength between the heat cured resin and micro wave cured resin.It shows p value is significant at level of 5% for the specimens immersed in Aerated drink.

Hence, the specimens immersed in aerated drink has lowest Impact strength value than other sub groups.

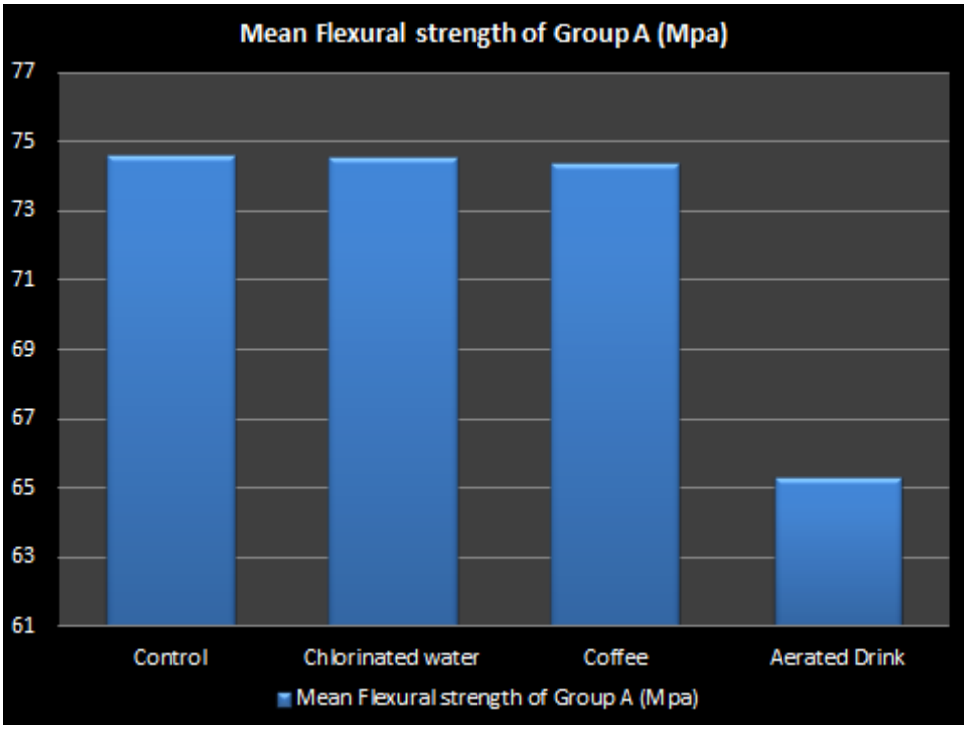
From the results and the statistical analysis it can be inferred that

Micro wave cured resin has better flexural strength values than heat cured resin in all sub groups and within the sub groups specimen immersed in Aerated drink has the lowest flexural strength.

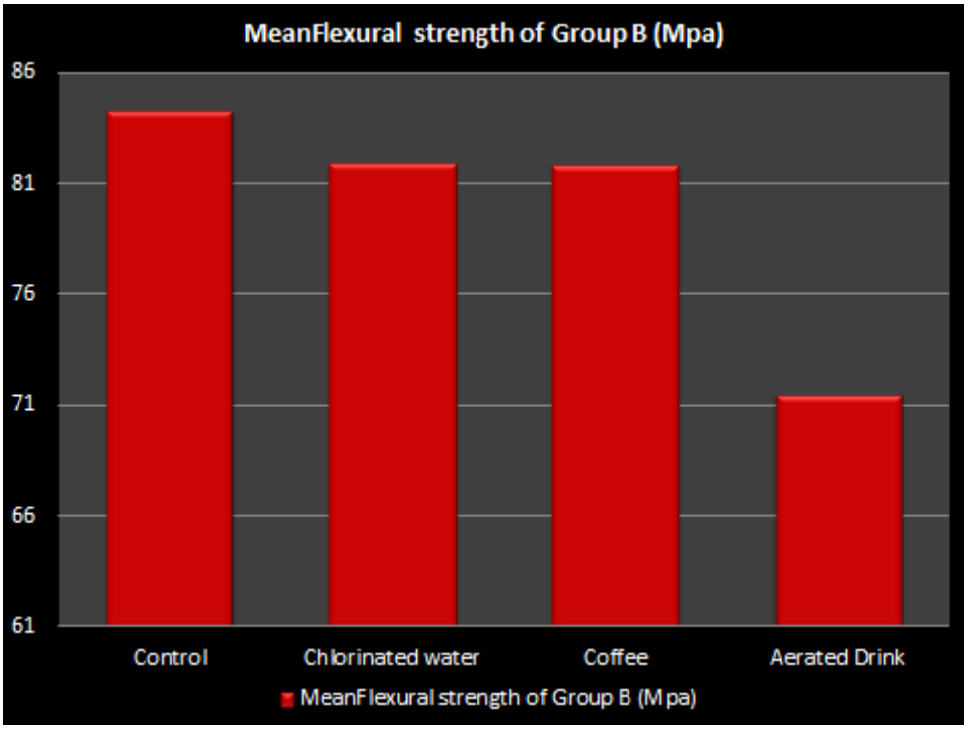
Micro wave cured resin has better Impact strength values than heat cured resin in all sub groups and within the sub groups specimen immersed in Aerated drink has the lowest impact strength.

BAR DIAGRAMS

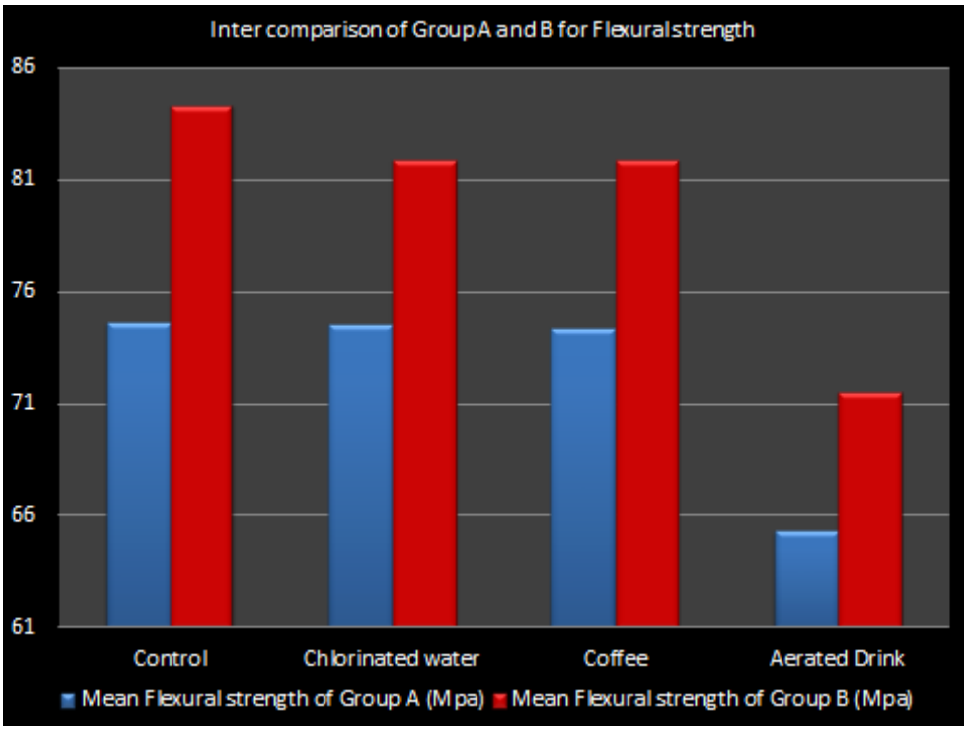
Bar diagram 1 shows comparison of sub groups in group A for Flexural strength



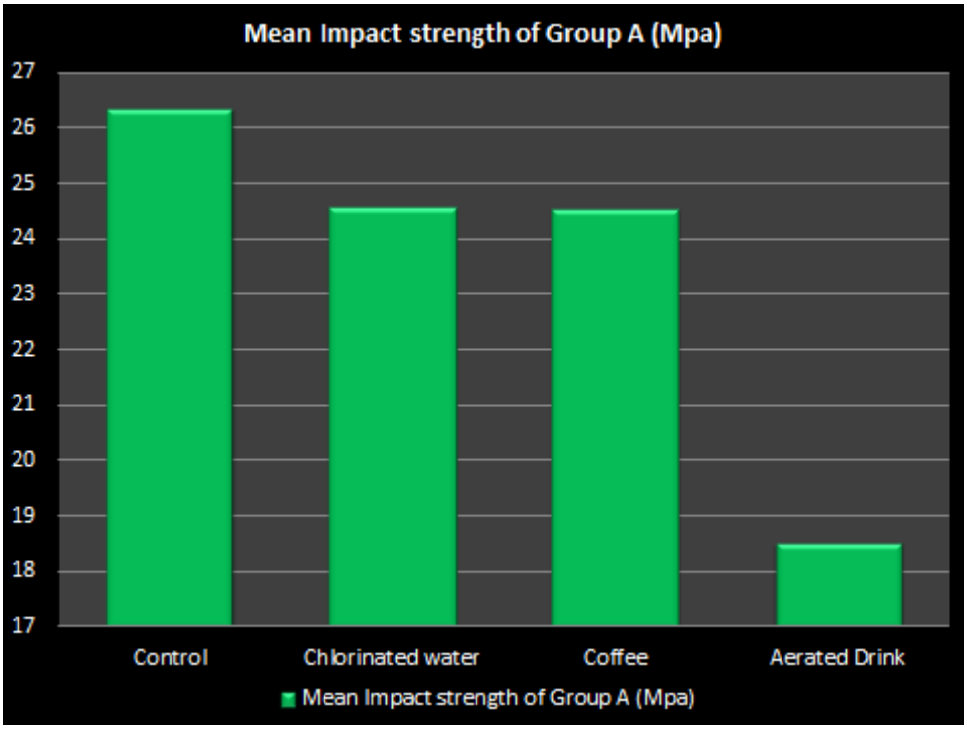
Bar diagram 2 shows comparison of sub groups in group B for Flexural strength



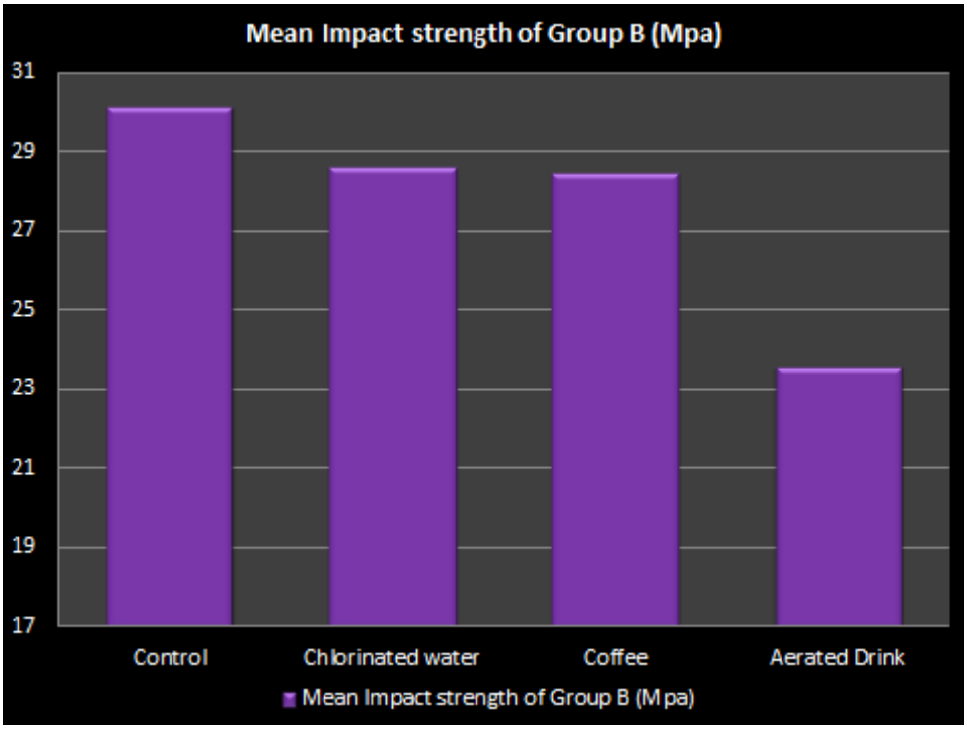
Bar diagram 3 shows inter comparison of group A and B for Flexural strength



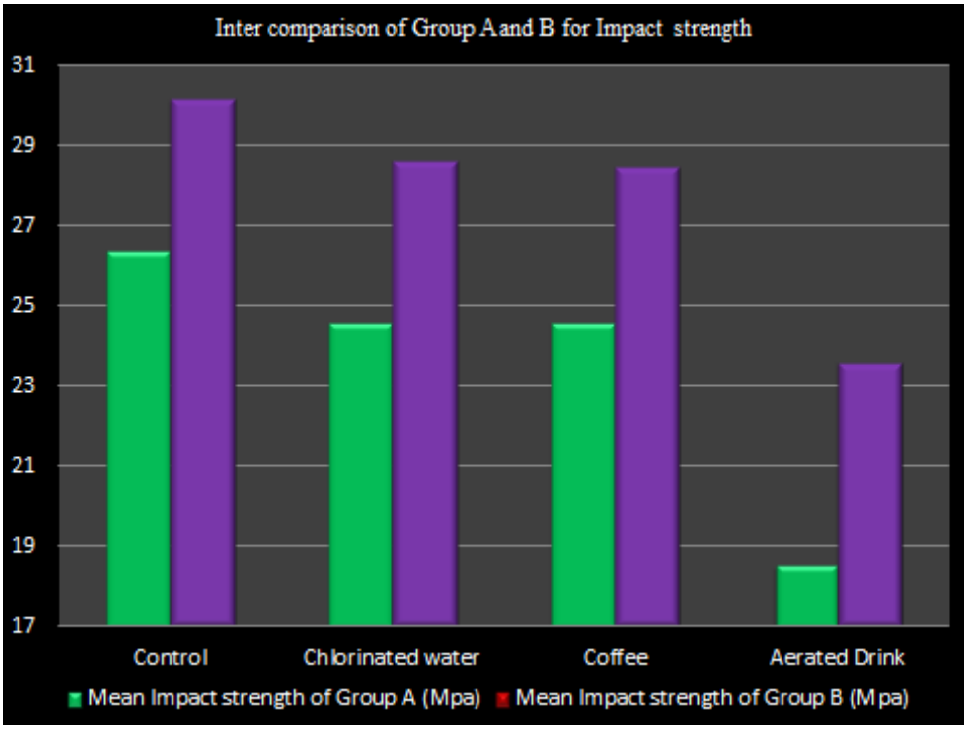
Bar diagram 4 shows comparison of sub groups in group A for Impact strength



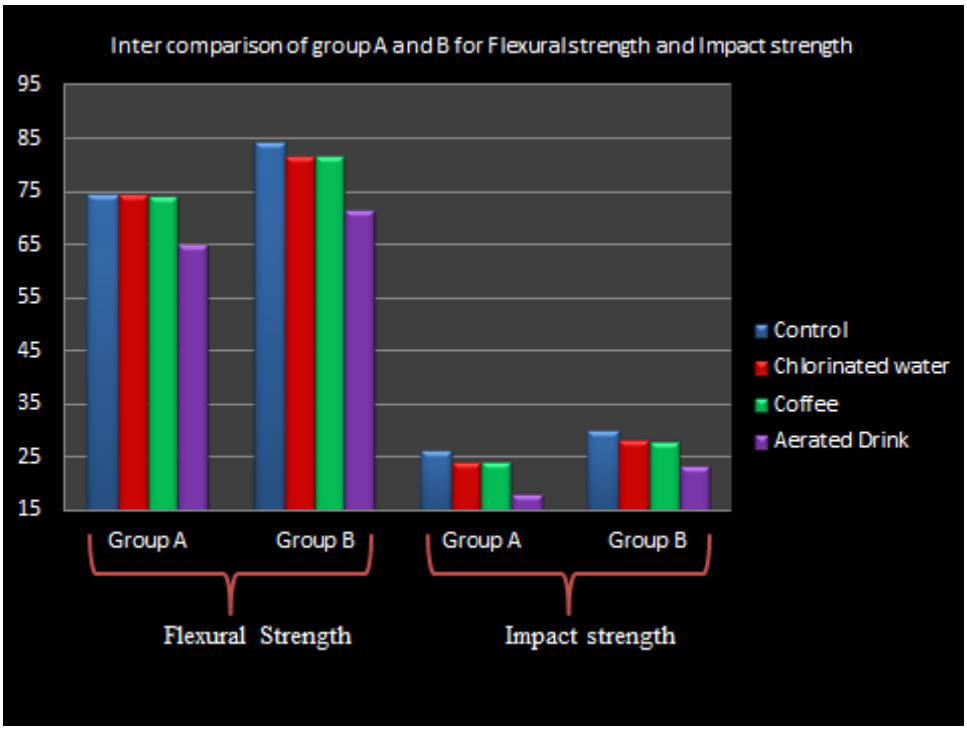
Bar diagram 5 shows comparison of sub groups in group B for Impact strength



Bar diagram 6 shows inter comparison of group A and B for Impact strength



Bar diagram 7 shows inter comparison of group A and B for Flexural strength and Impact strength



DISCUSSION

DISCUSSION

The poly methyl methacrylate was the material of choice for making dental prosthesis such as partial and complete dentures from 1937 onwards.[1]Although several materials were introduced and tried for denture construction.95% of complete dentures are now constructed by poly methylmethacrylate polymers because of the following advantagesof good esthetics, dimensional stability, ease of processing and accurate fit[1,3].These denture base resins are routinely polymerized either in a hot water bath or auto-curing method or light curing method, however it does have its ownadvantages and disadvantages. The heat cured denture base resin usually takes considerable amount of time for curing which is time consuming process.

To overcome this drawback various polymerization methods were introduced which includes polymerization by light curing and by microwave energy[4].The advantages of micro wave cured denture base resin include a greatly reduced curing time, less cumbersome equipment and a clean method of processing.[65]

The presence of Saliva and Oral fluids and the oral consumption of the individuals by means of routine diet may have their impact on the physical properties of denture base resin. Variations of P^H and thermal changes of these fluids and their chemical nature have been considered as the common causes.[8,9]

The sorption and solubility are the inherent qualities of these resins they produces deleterious effects on the processed denture base resin. These effects may include volumetric changes such as expansion, physical changes such as plasticization and softening, and chemical changes such as oxidation and hydrolysis which are directly affecting the physical properties.[8,9,10]

This study was proposed to comparesome of the physical properties such as the flexural strength and Impact strength of denture base resin routinely used.The heat activated denture base resin usually cured by conventional water bath and the denture base resin cured by micro wave energy were selected.Thesamples of these resins were immersed in three different fluid media which are routinely used in our day to day life.

The preparation of the samples was done according to the ISO Standard for flexural strength and impact strength and these samples were divided into eight experimental groups for heatcuredandmicrowavecuredresin. Microwave cured resin groups B1,B2,B3,B4 shows difference in flexural and impact strength with a p value of <0.001 which denotes significance at 1%levelMicrowave cured resin groups B1,B2,B3,B4 shows difference in flexural and impact strength with a p value of <0.001 which denotes significance at 1% level.

Statistical analysis of Variance One-way Anova between sub groups of micro wave cured resin and heat cured resin shows p value(<0.001) is significant at 1% level, the inter group comparison at a significance level of 5% shows that sub group B1,B2,B3 are significantly different from B4,which means that B1,B2,B3 has higher values than B4. Hence the samples immersed inaerated drink has the lowest flexural strength value for both the heat cured and micro wave cured resin.

Similarly for impact strength the samples immersed in aerated drink show lowest value for heat cured and micro wave cured resin than other sub groups.

In the conventional hot water bath curing of acrylic resin, the temperature outside the flask is almost the same as that inside and hence an unfavorable thermal gradient is created. Owing to this the heat generated during polymerization is accumulated and not allowed to escape,therefore the polymerization has to be conducted at a lower temperature for a long period of time.This low temperature curing takes longer time to convert the monomer to polymer and to complete the polymerization.[66]

In case of micro wave curingelectromagnetic waves, to generate the heat inside the resin during polymerization methyl methacrylate molecules orient themselves and changes their direction five billion times per second,this rapid heat arises will form free radicals for monomer conversion.as the temperature increases number of monomer molecules decreases resulting in lesser porosity. A form of self-regulationof the curing program takes place and leads to the complete polymerization of the resin. Within a short period of time when compared with heat cured resin.[67]

In conventional heat cure method, the monomer molecules are moved by thermic shocks they receive from other molecules, while in microwave energy method, there is almost no thermic inertia, which permits good control over the resin temperature and allows for curing at a strictly controlled low temperature.[68]

(Nishii, 1968)[18]Compared the mechanical properties of microwave polymerized resins and conventional heat cured denture base resin.They concluded that acrylic resin

processed by microwave energy presented the same characteristics of conventional method of heat cured denture base resin.

J.P.DeClerck et al(1987)[67] conducted Physical and chemical tests on microwave cured resins indicates that the impact strength tests showed no significant difference between conventional heat cured resin and microwave cured resins and there appears to be little internal stress in a microwave cured resin. Chemical tests showed an exceptionally low residual monomer in a microwave cured resin.

Rajlakshmi et al (2010)[60] compared the flexural fatigue strength of denture base resins polymerized by the conventional water bath, microwave, and pressure cooker polymerization techniques.Flexural fatigue strength of samples processed by the microwave technique showed statistically significant results. They concluded that polymerization procedure plays important role in influencing the flexural fatigue strength of denture base resins.

In our study micro wave cured resin samples shows better impact strength(30.14) and flexural strength values (84.30) which supports the study and this could be attributed to complete polymerization and reduced content of free monomer.

DéboraBarros Barbosa(2007)[51] Evaluated the influence of microwave polymerization on the flexural strength of a conventional heat-polymerized, a microwave-polymerized and auto polymerizing acrylic resins and concludedthat microwave-polymerized denture base resins exhibit flexural strength in the same range as other resins.

In our study micro wave cured resin(84.30) has shown highest flexural strength values than heat cured resin.(74.60).

Fernanda Faot(2006)[47]Evaluated the impact strength and fracture morphology of denture base acrylic resins processed by microwave energy and hot water bath and concluded that acrylic resins exhibited a high number of brittle fractures, irrespective of the processing technique.Heat cured resinLucitone and Ondacryl shows higher values than Vipi wave micro wave resin probably due to long curing cycle with low watt power.

In our study under normal curing time micro wave cured resin has higher impact strength than the heat cured resin.

Helena et al (2009)[57]Conducted a study to evaluate the flexural strength of acrylic resin immersing in sodium hypochlorite solution in various concentration such as 1%, 2.5% and 5.25%and simulating a 180 days immersion .He concluded that there were no significant values among with control group probably due to the temperature used in the solutions. And concentration of chlorine molecule .Higher temperature may affect water sorption and solubility of the denture base resin and decrease the flexural strength.

In our study there is slight decrease in flexural strength values for samples immersed in coffee(74,40) and chlorinated water(74.58) but the values are insignificant when compared to control group(74.60)

Mohammed Sohail and NorsiahYunus (2001)[35]Compared the impact and transverse strengths and the flexural modulus of a relatively new microwave-polymerized injection-molded polymer, microwave cured denture resin and a heat curedresin. The

flexural modulus of the new denture material was higher than the heat-polymerized resin.For impact and flexural strengths the microwave-polymerized,injection-molded,polyurethane-based polymer presented no significant change over the heat- and microwave cured denture base polymers.

Rola W. Abdul-Razaq and Noor F. Abdul-Hadi(2011)[61]Investigated the effect of aerated drink Pepsi on tensile bond strength with and without surface treatment of the denture base material. The results revealed that there was no significant difference in tensile bond strength, for all test specimens stored in water while there was highly significant difference for the test specimens stored in pepsi.This study shows definite influence of pepsi solution on poly methyl methacrylate resin.

In our study after the immersion in aerated drink, the sample from both heat cured and micro wave cured resin have the lowest value of flexural strength and impact strength when compared to other sub groups.

Acrylic resin dentures are notable for their tendency to absorb water, which causes corresponding dimensional change. Diffusion of water causes slight expansion of the polymerized mass and water molecules interfere with the entanglement of polymer chains and thereby act as plasticizers.

The change in the flexural and impact strength parameters recorded on statistical analysis showinfluence of carbonated beverage solutions on the denture base resin. The presence of phosphoric acidmay have to be considered as causative factor which acts as a the plasticizer and causes the changes in the flexural and impact strength.The mean values for groupsA and B stored in beverage showed decrease in impact and flexural strength in this study. This decrease in strength was may be to the hydrolysis of bond

between molecules bybeverage.The development of stress concentration and entrapment of air at the bond interface area weaken the flexural and impact strength. This result may be attributed to the acidic nature and basic composition of beverage which cause the hydrolysisof poly methyl methacrylate.

The PMMA contain ester group which easily hydrolyze in acidic pH which convert methacrylate to carboxylate and alcohol. The first step in the reaction involve theattachment of oxygen atom of carbonyl group with the proton(acidic hydrogen), in this step there will be increase in the electrophilicity of the carbon of the carbonyl group then the attachment of nucleophile(HO) group form carboxylic acid and alcohol.This could be attributed to the decrease in the flexural and impact strength.

Within the limitations and results of this study it was noticed that both heat cured and micro wave cured denture base resins are clearly affected by the oral fluids and intake which are mentioned in this study. The physical properties of these resins are very much affected by them and cause fracture and debonding of the tooth from the denture base during usage.

In any laboratory study, the samples used cannot be simulated biological structures exactly. This in vitro study was attempted to evaluate the mechanical properties of the denture base resin with two polymerization methods after immersion in different liquid media routinely used in day to day life. More emphasis has to be put forward to clinically evaluate the same.

SUMMARY

AND

CONCLUSION

SUMMARY AND CONCLUSION

This in-vitro study was conducted to evaluate the influence of various liquid medieathat come in contact to denture base resin in routine day to day life.

The permanent denture base resin polymerized by conventional water bath and micro wave energy was used in this study.A total number of 160 samples were prepared according to ISO standardizations which were divided into eight sub groups.Twenty samples were allotted for each sub group, out of which 10 samples were taken from heat cured resin and another 10 samples were taken from micro wave cured resin.All the prepared specimens were then subjected to testing for Impact strength and Flexural strength in the testing machine.

Within the limits of the in vitro study and from the results following conclusion were made

1. Micro wave cured resin has showed a significant increase in flexural strength when compared to heat cured polymerization.
2. Micro wave cured resin has showed a significant increase in Impact strength when compared to heat cured polymerization.
3. The specimen immersed in aerated drink has more damaging effect on the impact and flexural strength of samples of micro wave cured resin and it is followed by coffee and chlorinated water.
4. The specimen immersed in aerated drink has more deleterious effect on the impact and flexural strength of samples of heat cured acrylic resins and it is followed by coffee and chlorinated water.

Among the oral intake o individuals wearing prosthetic appliances such as partial and complete dentures the aerated drink was found to be more deleterious than other substances.

ANNEXURE

HEAT CURED DENTURE BASE RESIN(GROUP A)

SUB GROUP (A1 A2 A3 A4) FLEXURAL STRENGTH

A1 CONTROL

UNITS	MAX FORCE (N)	MAX FLEXURAL STRESS(MPa)
1	94.2563	78.2458
2	83.3251	68.6542
3	96.6542	78.5641
4	87.3654	71.5421
5	106.325	85.5124
6	76.6542	62.2541
7	98.3512	79.2135
8	90.6542	75.6512
9	80.8457	66.8457
10	98.2541	77.5624

A2-CHLORINATED WATER

UNITS	MAX FORCE (N)	MAX FLEXURAL STRESS(MPa)
1	103.828	79.5421
2	79.9375	74.2135
3	86.6525	66.3223
4	91.2969	72.1797
5	99.6563	77.2351
6	96.9456	68.2103
7	84.5612	72.8451
8	86.5884	70.2510
9	80.6541	81.3645
10	98.2314	83.6584

A3-COFFEE

UNITS	MAX FORCE (N)	MAX FLEXURAL STRESS(MPa)
1	88.1241	73.5421
2	81.2413	68.2135
3	74.2513	60.3223
4	79.4156	66.1797
5	86.2315	71.2351
6	76.3514	62.2103
7	80.2187	66.8451
8	78.2541	64.2510
9	92.2587	75.3645
10	95.2541	77.6584

A4-AERATED DRINK

UNITS	MAX FORCE (N)	MAX FLEXURAL STRESS(MPa)
1	86.1094	71.7578
2	96.5001	82.5835
3	90.9688	75.8073
4	118.438	98.6979
5	66.4375	55.3646
6	74.5982	66.5612
7	92.2465	80.6592
8	89.5623	74.5461
9	110.845	96,4562
10	78.5649	68.1254

SUB GROUP (A1 A2 A3 A4) IMPACT STRENGTH

A1 CONTROL

UNITS	ENERGY (J)	MAX IMPACT STRENGTH(J/m)
1	0.0465	23.8700
2	0.0521	22.9000
3	0.0554	26.0800
4	0.0611	23.9000
5	0.0487	26.7700
6	0.0412	23.8000
7	0.0543	25.8000
8	0.0450	25.8500
9	0.0402	22.9000
10	0.0622	23.9000

A2-CHLORINATED WATER

UNITS	ENERGY (J)	MAX IMPACT STRENGTH(J/m)
1	0.0515	23.2100
2	0.0523	24.2141
3	0.0662	24.1212
4	0.0486	28.2145
5	0.0625	22.7754
6	0.0452	22.8651
7	0.0554	24.5326
8	0.0516	23.6225
9	0.0412	24.3241
10	0.0649	27.6224

A3-COFFEE

UNITS	ENERGY (J)	MAX IMPACT STRENGTH(J/m)
1	0.0822	27.1420
2	0.0745	23.8700
3	0.0868	22.9000
4	0.0813	26.0800
5	0.0734	23.9000
6	0.0781	26.7700
7	0.0762	23.8000
8	0.0816	25.8000
9	0.0914	25.8500
10	0.0815	22.9000

A4AERATED DRINK

UNITS	ENERGY (J)	MAX IMPACT STRENGTH(J/m)
1	0.0596	19.87
2	0.0566	18.90
3	0.0662	22.08
4	0.0597	19.90
5	0.0683	22.77
6	0.0574	19.80
7	0.0616	21.80
8	0.0619	21.85
9	0.0566	18.90
10	0.0596	19.90

MICROWAVE CURED DENTURE BASE RESIN(GROUP B)

SUB GROUP (B1 B2 B3 B4) FLEXURAL STRENGTH

B1 CONTROL

UNITS	MAX FORCE (N)	MAX FLEXURAL STRESS(MPa)
1	102.251	79.7578
2	85.8456	90.5835
3	98.5612	83.8073
4	88.0423	90.0000
5	90.5213	73.0000
6	78.8521	74.5612
7	99.1432	88.6592
8	94.5620	82.5461
9	108.254	80.0000
10	98.3215	76.1254

B2-CHLORINATED WATER

UNITS	MAX FORCE (N)	MAX FLEXURAL STRESS(MPa)
1	90.4684	83.3724
2	84.2315	74.2188
3	76.2135	75.7943
4	80.2135	92.9948
5	96.5642	84.5182
6	101.365	82.5487
7	78.2541	74.5842
8	92.3600	83.6954
9	88.2541	76.5942
10	90.2588	90.3165

B3-COFFEE

UNITS	MAX FORCE (N)	MAX FLEXURAL STRESS(MPa)
1	88.0469	79.7578
2	71.0625	90.5835
3	78.9531	83.8073
4	99.5938	90.0000
5	89.4219	73.0000
6	82.4652	74.5612
7	71.5622	88.6592
8	87.8592	82.5461
9	74.5423	80.0000
10	96.2463	76.1254

B4-AERATED DRINK

UNITS	MAX FORCE (N)	MAX FLEXURAL STRESS(MPa)
1	77.5000	64.5833
2	87.7031	**73.0859**
3	79.8438	**66.6985**
4	93.5469	**77.6852**
5	78.8125	65.2541
6	76.5984	64.2451
7	84.5464	72.3561
8	90.4664	74.2513
9	89.4656	74.1212
10	72.8387	60.2451

SUB GROUP (B1 B2 B3 B4) IMPACT STRENGTH

B1 CONTROL

UNITS	ENERGY (J)	MAX IMPACT STRENGTH(J/m)
1	0.0635	33.0200
2	0.0563	36.8000
3	0.0584	19.8700
4	0.0345	19.8700
5	0.0421	32.2300
6	0.0853	30.2200
7	0.0684	32.1200
8	0.0654	23.4200
9	0.0625	22.3800
10	0.0812	36.2200

B2-CHLORINATED WATER

UNITS	ENERGY (J)	MAX IMPACT STRENGTH(J/m)
1	0.0870	30.2513
2	0.0895	29.8456
3	0.0836	29.7543
4	0.0852	27.4265
5	0.0762	30.4412
6	0.0742	32.5463
7	0.0854	30.2542
8	0.0625	29.8762
9	0.0865	29.6855
10	0.0812	31.3512

B3-COFFEE

UNITS	ENERGY (J)	MAX IMPACT STRENGTH(J/m)
1	0.0818	27.2708
2	0.0870	29.0000
3	0.0870	29.0128
4	0.0829	27.6300
5	0.0912	30.0000
6	0.0759	26.4591
7	0.0984	31.9842
8	0.0832	27.6548
9	0.0862	28.8542
10	0.0745	26.6495

B4-AERATED DRINK

UNITS	ENERGY (J)	MAX IMPACT STRENGTH(J/m)
1	0.0990	33.02
2	0.1104	36.80
3	0.0596	19.87
4	0.0596	19.87
5	0.0857	32.23
6	0.0672	30.22
7	0.0875	32.12
8	0.0784	23.42
9	0.0664	22.38
10	0.1992	36.22

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